THE FABRICATION OF BIOGAS SYSTEM TO PRODUCE METHANE GAS FROM COW DUNG

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ABSTRACT

The demand, high costs and health implications of using energy derived from hydrocarbon compound have necessitated the continuous search for alternative source of energy. Cow dung as a renewable source of energy supply has been proven to be very efficient. This study investigated the production of biogas using cow dung from cow field near the polytechnic. A 2ml/g of the cow dung was used in this study. The digestion was carried out in a 10 L anaerobic digester at a temperature of 250°C to 300°C and uncontrolled pH for a period of 1 month. About 23 cm³ of biogas was produced on the 22nd day. Thus biogas production from cow dung is a good and cheap alternative source of energy. The use of biogas will not only serve as a source of fuel but will also help in the management of waste. The biomass generated after digestion can be used both as animal feed and to improve soil fertility. It is therefore recommended that large scale production of biogas from wastes should be undertaken by all as the wastes around you today can become your wealth tomorrow.

Keywords: Biogas, Bioreactor, Cow dung, biomass

1.0 INTRODUCTION

Now a day’s biogas production is renewable source, mainly because of the fact that those resources are inexhaustible and they can be found at lower prices on
the market then the fossil fuel. Anaerobic digestion is one of the effectiveness processes to produce biogas. The raw material for produce the biogas, such as food waste, cow dung and digested slurry can be used as fertilizer. Co-digestion of cow dung or other feed stocks with low carbon content can improve process stability and methane production. (Adeniran et al., 2014)

Biogas is a combustible mixture of gases. It consists mainly of methane (CH$_4$) and carbon dioxide (CO$_2$) and is formed from the aerobic bacteria decomposition of organic compound. The gases formed are the waste products of the respiration of these decomposer microorganisms and the composition of the gases depends on the substance that being decomposed (Jergensen & Planenergi). This is produce when bacteria decompose organic material. Biogas is a mixture of about 60 percent and 40 percent carbon dioxide. Methane is the main component of natural gas. Methane contains chemical compound with the chemical formula CH$_4$ (one atom of carbon and four atoms of hydrogen). It is the simplest alkane and the main component of natural gas. The relative abundance of methane makes it an attractive fuel (Hankisham et al., 2003). However, because it is a gas at normal conditions, methane is difficult to transport from its source. Methane is relatively clean burning, colorless, and odorless. This gas can be captures and burned for cooking and heating. This is already being done on a large scale in some countries of the world. Farms that produce a lot of manure, such as hog and dairy farms, can use biogas generators to produce methane (Kaygusuz et al., 2004).

The disposal of organic waste to the landfill constitutes severe environment problems such as methane emission (greenhouse gas) (Tripodo et al., 2004). This can be solves by recoverable materials that are in organic such as food and plant material can be recovered through digestion processes to decompose the organic matter. Waste gas produced that is methane can be captured and used for generating electricity and cooking purpose. Energy demand is a critical reason for extensive climate change, resource exploitation and also restricts the living standards of human (Li et al., 2007).
1.1 Benefits

In North America, use of biogas would generate enough electricity to meet up to 3% of the continent's electricity expenditure. In addition, biogas could potentially help reduce global climate change. High levels of methane are produced when manure is stored under anaerobic conditions (Anunputtikul et al., 2004). During storage and when manure has been applied to the land, nitrous oxide is also produced as a byproduct of the gentrification process. Nitrous oxide (N$_2$O) is 320 times more aggressive than carbon dioxide and methane 21 times more than carbon dioxide. By converting cow manure into methane biogas via anaerobic digestion, the millions of cattle in the United States would be able to produce 100 billion kilowatt hours of electricity, enough to power millions of homes across the United States (Oyeleke et al., 2003). In fact, one cow can produce enough manure in one day to generate 3 kilowatt hours of electricity; only 2.4 kilowatt hours of electricity are needed to power a single 100-watt light bulb for one day. Furthermore, by converting cattle manure into methane biogas instead of letting it decompose, global warming gases could be reduced by 99 million metric tons or 4%.

1.2 Biogas upgrading

Raw biogas produced from digestion is roughly 60% methane and 29% CO$_2$ with trace elements of H$_2$S; it is not of high enough quality to be used as fuel gas for machinery. The corrosive nature of H$_2$S alone is enough to destroy the internals of a plant. Methane in biogas can be concentrated via a biogas up grader to the same standards as fossil natural gas, which itself has had to go through a cleaning process, and becomes bio methane (Esan et al., 2008). If the local gas network allows, the producer of the biogas may use their distribution networks. Gas must be very clean to reach pipeline quality and must be of the correct composition for the distribution network to accept. Carbon dioxide, water, hydrogen sulfide, and particulates must be removed if present (Lopes et al., 2004). There are four main methods of upgrading: water washing, pressure swing adsorption, selexol adsorption, and amine gas treating. The most prevalent method is water washing where high pressure gas flows into a column where the carbon dioxide and other trace elements are scrubbed by cascading water running counter-flow to the gas. This arrangement could deliver 98% methane
with manufacturers guaranteeing maximum 2% methane loss in the system. It takes roughly between 3% and 6% of the total energy output in gas to run a biogas upgrading system (Tyagi et al., 1981).

1.3 Biogas gas-grid injection

Gas-grid injection is the injection of biogas into the methane grid (natural gas grid). Injections includes biogas until the breakthrough of micro combined heat and power two-thirds of all the energy produced by biogas power plants was lost (the heat), using the grid to transport the gas to customers, the electricity and the heat can be used for on-site generation resulting in a reduction of losses in the transportation of energy. Typical energy losses in natural gas transmission systems range from 1% to 2%. The current energy losses on a large electrical system range from 5% to 8% (Baki et al., 2004).

2.0 OBJECTIVE OF THE STUDY

1) To design mini plant for biogas process
2) to produce the methane gas from animal waste (cow waste)
3) to produce the organic fertilizer from animal waste

3.0 METHODOLOGY

3.1 Design

Three most common and most successful design for the biogas digester are the fixed dome, the plastic covered ditch and floating drum, so we choose the floating drum as our project design because the technology is simple and easy to reproduce (Figure 1).

3.2 Floating Drum Bio digester Design

Floating drum digesters are operated by feeding manure mixed with water into a digester inlet pipe. The slurry flows down the inlet pipe and enters the bottom of the
digester. There is a layer of bios lids on the bottom and a layer of liquid effluent above that.

![Figure 1: Design for the biogas digester.](image)

The bucket is mounted on the container with water jacket located outside the digester, and as the pressure of biogas increases in the drum, the drum rises accordingly. Therefore, we must put the heavier rock or brick on the bucket so that the bucket would not fall off easily as the bucket rise. To reduce the construction cost the floating gas drum can be replaced by a balloon above the digester, but in practice problems always arise with the attachment of the balloon at the edge (Godi et al., 2013).

4.0 RESULTS AND DISCUSSION

Figure 2 shows the picture from this work and from previous research. As we can see in figure 2 there are differences between actual and previous research. Blue flames aren’t always hotter than yellow flames, because the color of light emitted by the flame can depend on exactly which atoms and molecules are in the flame. Each atom or molecule has certain special frequencies (colors) at which it absorbs and emits light sometimes that’s more important than the temperature of the flame in setting the color. Some chemicals burn with a blue color; for example, so that if
burning some of these on an ordinary fire it will show color of blue. This does not mean that the temperature of the whole fire went up, just that these chemicals made the color change (Ukpai et al., 2012).

Figure 2: (A) the picture shows the actual result; (B) and (c) the picture shows the previous research.

However, there are cases that follow the simple pattern, where the flame color changes smoothly from yellowish to bluish as it gets hotter (Rabah et al., 2010). Simple burners fueled by oxygen and propane typically behave this way. The key to making sense of this turns out to be that the energy emitted into the light comes in little packets, called quanta. High-frequency (bluish) light has high energy quanta and low-frequency (reddish) light has lower energy quanta. Temperature measures how much thermal energy is available to go into vibrating particles, including the particles emitting the light. If the typical thermal energy of a particle is large compared to a quantum of light of some color, that color of light is easily emitted. But if the energy quantum is bigger than the typical thermal energy scale, those quanta hardly ever come out (Okure et al., 2005). So as heating something up, first the lower energy (red) quanta show up, then also middle energy (say green), and finally they’re joined by blue quanta. This process makes no sense in classical physics, where there’s no packet-size for light waves, so it provided the first key to the modern physics of quantum mechanics. The actual color is set by the mixture of different light frequencies. Orange or yellow flames have fairly high wavelengths (low frequency) - most of the light being produced is actually in the infrared range, which invisible. Blue-ish flames have much lower wavelengths (high frequency) with a lot of the light off towards the ultraviolet range (Richards et al., 1994).
Flame is white-blue and has hard, sharp features.
Possible Cause
   1. Excessive primary air.
Corrective Action
   1. Adjust air shutter.

Flame is small and blue in color.
Possible Cause
   1. Clogged burner orifice.
   2. Clogged venture.
   3. Restricted or clogged gas line.
   4. Excessive low gas pressure.
Corrective Action
   1. Clean or replace burner orifice.
   2. Clean venture. Replace burner, if necessary.
   3. Remove & clean the gas supply line. Replace, if necessary.
   4. Use a manometer and adjust the gas pressure.

Flame is yellow and/or causing soothing on cooking utensils.
Possible Cause
   1. Insufficient primary air.
   2. Blocked primary air shutter.
   3. Oversized burner orifice.
Corrective Action
   1. Increase primary air shutter.
   2. Clean primary air shutter & adjust for proper air-gas mixture.
   3. Replace burner orifice.

Flame is noisy (rumbles or gurgles).
Possible Cause
   1. Excessive primary air.
   2. Excessive gas pressure.
Corrective Action
   1. Clean primary air shutter & adjust for proper air-gas mixture.
2. Use a manometer and adjust the gas pressure.

**Orifice noise (burr or high-pitched squeal).**

Possible Cause

1. Debris lodged in orifice.
2. Improper orifice size.
3. Excessive gas pressure.

Corrective Action

1. Clean orifice. Replace, if necessary.
2. Replace orifice.
3. Use a manometer and adjust the gas pressure.

Chemical reaction and typical composition of biogas as shown in Table 1.

Table 1: The composition of biogas and chemical reaction

<table>
<thead>
<tr>
<th>compound</th>
<th>Molecular Formula</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>methane</td>
<td>CH₄</td>
<td>50 – 75</td>
</tr>
<tr>
<td>carbon dioxide</td>
<td>CO₂</td>
<td>25-50</td>
</tr>
<tr>
<td>nitrogen</td>
<td>N₂</td>
<td>0-10</td>
</tr>
<tr>
<td>hydrogen</td>
<td>H₂</td>
<td>0 – 1</td>
</tr>
<tr>
<td>hydrogen sulphide</td>
<td>H₂S</td>
<td>0 – 3</td>
</tr>
<tr>
<td>oxygen</td>
<td>O₂</td>
<td>0 - 0</td>
</tr>
</tbody>
</table>

Chemical reactions:

- Acetic acid → methane + carbon dioxide
- Ethanol + carbon dioxide → methane + acetic acid
- Carbon dioxide + hydrogen → methane + water
5.0 CONCLUSIONS

The result of this research on the production of biogas from cow dung has shown that flammable biogas can be produced from these wastes through anaerobic digestion for biogas generation. These wastes are always available in our environment and can be used as a source of fuel if managed properly. The study revealed further that cow dung as animal waste has great potentials for generation of biogas and its use should be encourage due to its early retention time and high volume of biogas yields. Also in this study, it has been found that temperature variation, pH and Concentration of Total solid, are some of the factors that affected the volume yield of biogas production (Webber et al., 2008).

REFERENCES


Tyagi, T. H. (1981). Batch and multistage continuous ethanol fermentation of cellulose hydrolysate and optimum design of fermentor by graphical analysis, biotechnology and bioengineering.
